Los Alamos among new DOE projects to create new technology pathways for low-cost fusion energy development

July 20, 2015

The Energy Department's Advanced Research Projects Agency-Energy (ARPA-E) on May 14, 2015 announced $30 million in funding for 9 groundbreaking new projects aimed at developing prototype technologies to explore new pathways for fusion power. Three of the projects involve Los Alamos National Laboratory science staff and partners.

The projects are funded through ARPA-E's Accelerating Low-cost Plasma Heating and Assembly (ALPHA) program, which seeks to develop low-cost fusion energy technology solutions.

"These new projects emphasize ARPA-E's commitment to developing a wide range of technology options to ensure a more affordable and sustainable energy future," said

ARPA-E Director Dr. Ellen D. Williams. “Investing in … intermediate density fusion illustrates ARPA-E’s role in accelerating energy research and development.”

Details on ALPHA’s nine projects may be found here.

The Los Alamos National Laboratory projects are the following:

Spherically Imploding Plasma Liners as a Standoff Magneto-Inertial-Fusion Driver- $5,875,000

Los Alamos National Laboratory (LANL), teamed with Hyper V Technologies and a multi-institutional team, will develop a plasma-liner driver formed by merging supersonic plasma jets produced by an array of coaxial plasma guns.

The key virtues of a plasma-liner driver, as noted by project leader Scott Hsu, are that it (1) has *standoff*, i.e., it completely avoids hardware destruction because the plasma guns are placed sufficiently far away (many meters in an eventual fusion reactor) from the region of fusion burn, and (2) it enables high implosion velocity (50–100 km/s) to overcome thermal transport rates inherent in desired targets.

This non-destructive approach may enable rapid, low cost research and development and, by avoiding replacement of solid components on every shot, may help lead to an economically attractive power reactor. This project will seek to demonstrate, for the first time, the formation of a small scale spherically imploding plasma liner in order to obtain critical data on plasma liner uniformity and ram pressure scaling. If successful, this concept will provide a versatile, high-implosion-velocity driver for intermediate fuel density magneto-inertial fusion that is potentially compatible with several plasma targets. These experiments will be conducted on the existing Plasma Liner Experiment (PLX) facility at Los Alamos.

Stabilized Liner Compressor (SLC) for Low-Cost Fusion

NumerEx, LLC, teamed with the National High Magnetic Field Laboratory in Los Alamos, NM, will develop the Stabilized Liner Compressor (SLC) concept in which a rotating, liquid metal liner is imploded by high-pressure gas.

Image caption: The Stabilized Liner Compressor (SLC) is a system that uses high-pressure gas and a free-piston to implode a liquid metal liner onto trapped magnetic flux in order to achieve controlled fusion at very high magnetic fields (~100 T).

“The SLC project provides an opportunity to leverage advances in materials in a new era of computation capabilities while developing a revolutionary high magnetic field capability with a distinct purpose,” said Los Alamos project leader Chuck Mielke.

Free-piston drive and liner rotation avoid instabilities as the liner compresses and heats a plasma target. If successful, this concept could scale to an attractive fusion reactor with efficient energy recovery, and therefore a low required minimum fusion gain for net energy output. The SLC will address several challenges faced by practical fusion reactors. By surrounding the plasma target with a thick liquid liner, the SLC helps avoid materials degradation associated with a solid plasma-facing first wall. In addition, with an appropriately chosen liner material, the SLC can simultaneously provide a breeding

blanket to create more tritium fuel, allow efficient heat transport out of the reactor, and shield solid components of the reactor from high-energy neutrons.

“We recognized back at the Naval Research Laboratory in the 1970s that there may exist an optimum regime for controlled fusion at much higher magnetic fields than used by the mainline magnetic fusion program, but at much lower power density than required for laser fusion. The resulting power reactor and the necessary experimental prototypes need the repetitive, stabilized operation at megagauss field-levels offered by SLC,” said Peter J. Turchi, Los Alamos Guest Scientist and Senior Consultant to NumerEx LLC.

Prototype Tools to Establish the Viability of the Adiabatic Heating and Compression Mechanisms Required for Magnetized Target Fusion

Caltech, in coordination with Los Alamos National Laboratory, will investigate collisions of plasma jets and targets over a wide range of parameters to characterize the scaling of adiabatic heating and compression of liner-driven magnetized target fusion plasmas.

“Los Alamos will provide plasma physics modeling of the experiments to be carried out at Caltech to understand the critical processes during the plasma-cloud interactions,” said Hui Li, the lead Los Alamos scientist on the project.

The team will propel fast, magnetized plasma jets into stationary heavy gases or metal walls. The resulting collision is equivalent to a fast heavy gas or metal liner impacting a stationary magnetized target in a shifted reference frame and allows the non-destructive and rapid investigation of physical phenomena and scaling laws governing the degree of adiabaticity of liner implosions. This study will provide critical information on the interactions and limitations for a variety of possible driver and plasma target combinations being developed across the ALPHA program portfolio.